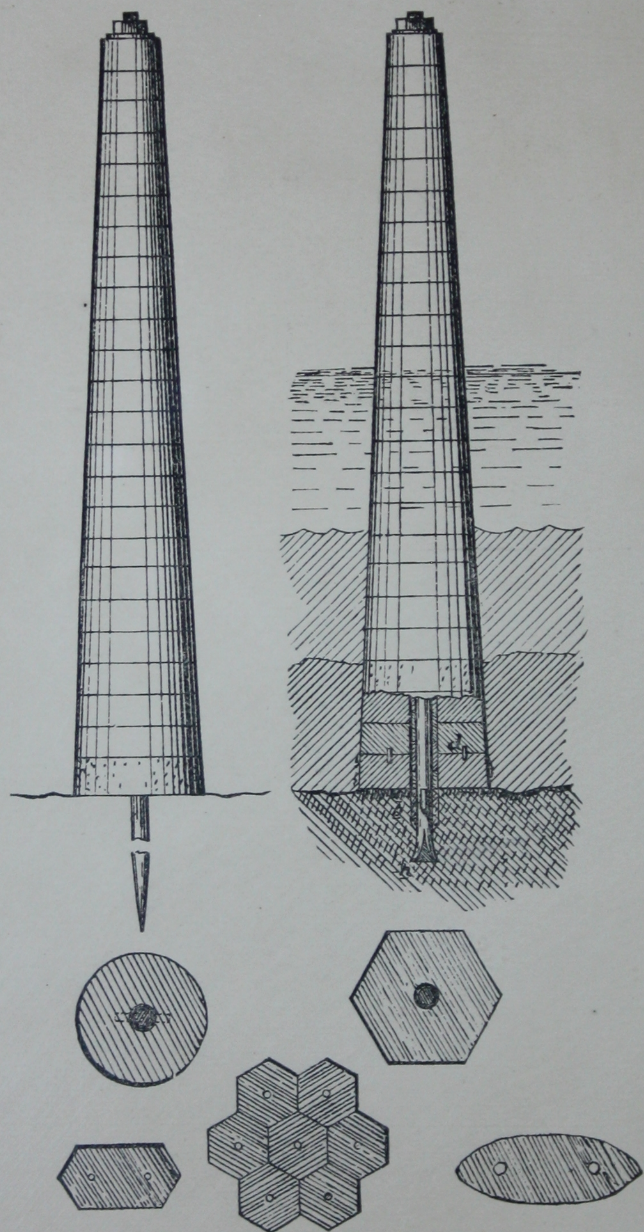
AMERICAN
PIER & COLUMN CO.

1874.

Plate I.



AMERICAN

PIER & COLUMN COMPANY,

76 WALL STREET, NEW YORK.

WHARVES, BRIDGES, VIADUCTS.

LIGHT-HOUSES, BEACONS, BREAKWATERS.

NEW YORK:
GEORGE F. NESBITT & CO., PRINTERS,
CORNER PEARL AND PINE STREETS.
1874.

conditions corrosion cannot take place; and being thus enclosed and supported throughout its entire length by an unyielding substance, the metal is in no danger of suffering from vibration.

When the Column has been thus carried up to the requisite height, and a thread, or a threaded sleeve placed upon the metal for that purpose, a small portion of its tensile strength is brought into requisition by means of a nut or other device to bind the members of the Column together, and give it all the rigidity of a single stone.

It will now be apparent to the reader that to bend or deflect the structure from its perpendicular, one of two things must take place; either the granite must yield and be crushed by the pressure, or the metal must stretch and be broken under the tensile strain. To crush the granite a force of at least five hundred tons per square foot must be applied, and the metal, if of rolled Bessemer steel, may be relied upon to resist an ultimate strain of fully seventy-five tons per square inch of cross section.

Fairbairn, whose authority will not be questioned, shows in his admirable work upon Iron, that in a series of seven experimental tests, conducted at Woolwich, England, this wonderful result of what he calls "Mr. Bessemer's beautiful process" showed a resistance to tensile strain, averaging 153,676 pounds per square inch, and it is claimed that the American ores, and the improved methods of manufacture adopted since that time, enable our manufacturers to exceed even these enormous figures.

Not only does the metal furnish a "bond" between the blocks which supplements the mortar a hundred fold, and renders them a practical unit, but it also binds the whole to the bottom, by the force of its entire tensile strength, in addition to the weight of the Column, giving to it a stability hitherto attained only by the mere gravity of enormous masses of material.

It needs little argument to demonstrate that a structure weighing, say five hundred tons, and furnished with a reliable bond to the rock on which it rests, of say, fifteen hundred tons, has greater stability—all other things being equal—than one weighing double, or even treble as much, having no such bond.

It is also to be observed, that the metallic piles, forming the core of this Column, having been sleeved at the top of the masonry, and the "clamp" taken upon the blocks, may be left extending upward through or into any superstructure resting upon the columns, and by means thereof, such superstructure may be made homogeneous with the foundations upon which the bearing Piles or Columns rest, without in any degree impairing the efficiency of the latter.

Vertical joints, the never-failing source of weakness in all ordinary structures of masonry, rendering a slight failure of the foundations fatal to their integrity, if of any considerable height, are here dispensed with; the "bond" of the mortar, always a treacherous and uncertain reliance, is

supplemented by the steel to such a degree as to render the question of its cohesion no longer of importance, and the adherance to the foundation is made so great that the mere gravity of the mass becomes a comparatively insignificant item in the calculation of stability.

The wide range of adaptability which such a Column possesses, and the great commercial importance of many of its uses, need not be dwelt upon. Wharves, Bridges, Light-houses, and their several modifications, are among the most obvious, as well as the most important, inasmuch as they are the "landmarks" of civilization.

Wharves.

The peculiar characteristics required in a Wharf, growing out of the diversity of position as to currents and shore, of bottom on which it rests, of tide-rise at different ports, and of purposes for which it is to be used have afforded ample ground for discussion among engineers in all countries and at all times. But nowhere else, apparently, has this discussion been so fruitless of improvement as in the City of New York.

The disgraceful condition of her wooden Wharves has furnished a constant theme for severe criticism during a quarter of a century past.

So early as 1856, the Harbor Commissioners, in a report to the Legislature, wrote as follows:

"The present mode of building our wharves is very reprehensible, and should be at once improved, or else the work of building piers of wood should be entirely abandoned;"—and yet this "reprehensible mode" has not been materially improved, nor has the building of wooden wharves been abandoned.

On the contrary, immense wooden sheds, in response to the imperative demands of commerce, have been added to the wooden Wharves, to afford shelter for the thousand millions of dollars' worth of merchandise which annually passes over them.

One single attempt at building a substantial wharf has indeed been made, that designed by Gen'l McClellan, at No. 1 North River; but, unfortunately, involving such a vast outlay as to forbid its repetition; leaving the Commissioners of Docks no alternative but to continue the "reprehensible mode," and build more wooden wharves and wooden sheds, of larger dimensions than any hitherto constructed, and consequently rather more certain to destroy the ships and cargoes alongside of them, in case a fire should break out upon them.

It is argued that such wharves are cheaper than more durable ones would be, and therefore to be tolerated.

Undoubtedly they do require less original outlay; but are they cheaper?

A wooden building costs correspondingly less than a fire-proof one, and yet its erection within the built-up portions of the city is absolutely forbidden by law. Why? Manifestly for reasons of public economy and security, and for no other.

It has been found that no such city can afford to allow buildings of wood to be erected, to serve as "kindling" for a conflagration; and the lesson in economy which Chicago and Boston

learned in a single night from the toleration of wooden buildings and Mansard roofs, may be as suddenly and savagely taught to the "commercial emporium of the continent," by the wooden Wharves and wooden sheds, which are already almost contiguous along her water front.

By substituting for supports, such Columns as are above referred to, not only does an incombustible wharf become possible, within a comparatively small cost, but it is susceptible of being covered by a fire-proof shed or warehouse, resting upon continuations of the columns themselves, and by means of the steel centers, anchored to the foundations of the wharf.

Such a structure, made a unit by the girders which bind the tops of the columns together, indestructible by fire, water, or the worm, presenting the minimum of obstruction to the tidal flow, affording the amplest opportunity to discharge from the slips the sewerage filth—which, upon the testimony of the Assistant Engineer of the Department of Docks, is so noxious as actually to prolong the life of wooden piles by rendering the water too offensive for the not over dainty "ship-worm"—capable of carrying a load sufficient to crush and destroy the strongest wooden wharf ever built, is brought at a reasonable cost within the reach of those who hold control of these indispensable adjuncts to commerce.

Again, quoting from the Report of the Harbor Commissioners in 1856, we add:

"No subject more intimately connected with the prosperity and greatness of the city can be entertained or considered by its authorities than the one now under consideration." And what is true of the City of New York in this respect is also true of every important harbor and port in the United States.

Bridges.

It is not a little surprising that while the best engineering talent of the world has been directed toward the improvement of the superstructure of Bridges with such signal success, substituting iron and steel for wood, or combining the two until some of the modern examples of the art are marvels of strength, durability and elegance, the substructure, or Piers, remain essentially the same as for centuries past.

Masonry Piers, with no bond save what their gravity confers, must of necessity be very ponderous, in order to maintain themselves against lateral displacement or dismemberment, and hence they bear no true relation to the superincumbent loads they are intended to carry.

The weight to be carried by any such pier would, in almost every case, be amply sustained, by a mere fraction of the stone employed, if that fractional portion could be safely and surely held in its proper vertical position, the only purpose served by the greater part of the material, being simply to maintain the position of that portion actually used or needed, and by its added weight to give the structure the needful adherence to the foundation.

When the foundation is soft or treacherous, provision must be made to sustain a load, often ten-fold greater than that which the practical use of the Bridge itself requires, and as in such a case the area to be made secure is too large to be enclosed by a coffer dam and thoroughly examined, the engineer has no alternative but to build upon a doubtful foundation, and take the chances of failure; reasoning, and oftentimes correctly, that if the foundations sustain the enormous weight of the Piers, they will not fail to any great extent under the trifling additional weight which the Bridge and its load imposes. The cost of preparing, transporting, and laying so many tons of useless material, especially where stone is scarce and labor dear, renders the accomplishment of the same result, by means of the combination of the stone with steel, in the manner already indicated, of great advantage to the economy of the case.

Moreover, in rivers where currents are swift, and subject to sudden floods, or where more or less debris of various sorts is carried along with it, by which the stream is liable to become choked, it is of great importance to diminish, as far as practicable, the surface area exposed against the moving water.

The following letter from a civil engineer of wide experience, whose name will be familiar to most railroad men, especially in the West—recites the details of a case which came under his professional observation—so much in point as to render any further elucidation of this branch of the subject quite unnecessary.

CHARLES E. HILL, Esq., *Pres.*,
Am. Pier and Column Co.

SIR,—In answer to your inquiry, relative to the bridge, crossing the Mississippi River at Rock Island, Illinois, and the effect of the ice-gorge thereon, I beg leave to submit the following facts from memory of my observations at that time.

Some six years ago, there was an extraordinary "gorge" of ice, at the point above named, on the occasion of the breaking up of the ice-bound condition of the river.

The constructing of this bridge precisely *at the foot of the rapids*, at Rock Island, no doubt supplied a barrier to the free discharge of the ice when the river broke up; but the bridge had been built a number of years, and up to this time had resisted all the pressure brought against it by any floods or ice gorges which had occurred.

The pier in the middle of the bridge was, as I believe, built by Reynolds, Saulpaugh & Co., of Rock Island, whose reputation as builders is good, and was, I think, of Joliet Stratified Limestone, with pieces in mass, large enough to make first class masonry, as the sequel will show.

The foundations were a practically horizontal bed of Trenton limestone, and the dimensions not far from the following, say, at base 50 feet long, and 16 feet wide, giving an area of 800 square feet; the top about 30 feet long, and 8 feet wide, giving an area of 240 feet, and the height to the grade not less than 30 feet.

There were, therefore, fully 15,600 cubic feet of masonry in the pier. Now allowing it to weigh a ton to each 14 cubic feet, the total weight would be about 1,114 tons, to which should be added, the weight proportionately of two spans of superstructure of 180 feet each, (one end of each of which rested upon this pier) the whole probably making a superincumbent weight of more than 2,000 tons.

When the ice broke up in the river it "gorged," especially on this pier, and *moved it on its foundation together with its superincumbent load, down the stream fully sixteen feet*, so that when you stood at one end of the bridge, (which was a straight line one) you could not see through it to the other end.

Mr. L. B. Boomer, of Chicago, who was the contractor, and built up the "false work at the head of the displaced pier and moved the bridge back into line," so that it could be used, will doubtless be able to recall and verify these facts.

Many conclusions might be drawn from this "bit of experience," in favor of your column, which presents so much less area of resistance, for an equal amount of strength to resist.

Hastily yours, &c.,

JAMES E. ABBOTT, *Civil Engineer.*

NEW YORK, *October 22d*, 1874.

Instances have become so frequent of Piers being thus displaced, or destroyed altogether, by gorges of this sort, as to drive builders to the very extremes of length of single spans, or the substitution of suspension bridges, to avoid them; while the statistics show, that notwithstanding all this effort, the *average* obstruction to currents by Bridge Piers and abutments, amounts to fourteen per cent. of the aggregate sectional area of the water-ways across which they pass.

Plate V. suggests an elliptical shape, applicable to such rapid currents. Figure 1 being an end view, and Fig. 2 a side view of the same Column, (with two steel shafts instead of one) and being divided above the high-water line into two distinct Columns, which may, when necessary, be slightly diverged to meet a given case.

Sleeve, cap, adjustable hub, and plan views of the base blocks, are also shown.

Under the head of Light House, Beacon and Breakwater Structures, will be found illustrations of a solid cluster of these Columns hexagonal in form, which is also applicable to a solid Pier for any purpose likely to require a greater area than could conveniently be attained in a single block of stone.

Considerations such as are referred to on the preceding pages undoubtedly led to the adoption of cast iron tubes filled with concrete (pneumatic piles), which, a few years ago, promised a solution of the difficulty; but experience has proved that iron, when exposed to the action of salt water, soon loses its cohesion and becomes useless.

But even if this were less fatal to their durability than it is, their use upon a hard bottom, would remain to be inexpedient, inasmuch as having no anchorage to the foundation, they are liable to be "tripped" out whenever by accident they are lifted off their "feet" or subjected to a severe lateral pressure.

Upon a soft or mud bottom, the case is scarcely better, because of the great cost and difficulty of sinking such tubes to a firm foundation; while a failure to do so leaves them liable to settle after they are filled, and fall out of a perpendicular.

Moreover, in a rigorous climate, the effect of frost upon the water which is always liable to accumulate within the tubes above the external water line, is exceedingly likely to fracture the shell and thus accomplish its early destruction.

The bridge which carries the Third Avenue across the Harlem River in the City of New York, was erected but eight or nine years ago upon these piles, put down in the very best manner and at great cost, by a builder second in reputation to none in this country—and yet Mr. Controller Green, in a letter published within a month, declares, that it has fallen out of repair, the draw can be worked only with great difficulty, and it must soon be replaced.

The reports of surveys made by United States engineers, upon various iron light house structures, published by the Light House Board, fully establish the fact, that iron exposed to the corrosive action of salt water, is not to be relied upon for a permanent support. Mr. John D. Van Buren, Jr., in an elaborate paper presented to the American Society of Civil Engineers, in June last, (from which we have already quoted), treating upon iron as adapted to wharf construction, says: "Certain kinds of cast iron could, perhaps, be made to last 50 years; "but already authentic rumors are afloat, that our cast-iron light houses are materially injured "by corrosion. Fifty years is a generous allowance, and probably greatly exceeds the average "life of cast iron in salt water. It is very doubtful whether any type of iron wharf will pay, "by its increased durability, for its greatly increased cost over that of a wooden structure." But the simple fact of its destructibility does not constitute so grave an objection to its use for the purposes referred to, as the equally well-settled point, that it is utterly impossible to determine beforehand the period of time at which it will give way, or to detect by examination (as in wood) the approaching change.

With the many examples of failure in various parts of this and other countries before him, and in the face of such professional and practical testimony as is to be obtained from sources such as have been referred to, a prudent and conservative builder would hesitate long before entrusting an important structure, intended to be permanent, to such a questionable support.

By thus placing the metal *externally*, and the masonry *within* it, he exposes that which requires protection, and carefully protects that which not only needs no protection, but which, if its relative position were reversed, would furnish to the metal, in the amplest degree, the very shelter which its durability demands.

This is precisely the combination of material which these Columns offer, and being entirely solid, no water, either by condensation or otherwise, can accumulate within them to be frozen; being anchored to the foundation, they cannot be "tripped" out or displaced laterally; while by the mode of their construction, the true and reliable foundation may be reached, and the danger of further settlement fully guarded against.

Moreover, a simple calculation of the outlay will show, that where the height of the Column required is fifty feet or upward, and the diameter of the cast iron tube is seven to eight feet, two of our Columns may be erected at less than the cost of one of the other, with a gain in resistance to lateral pressure applied at the top, of nearly ten-fold, by reason of the wider base and the anchorage to the foundation.

An open cluster, or "bent," of such Columns, consisting of four or six, as illustrated on Plate VI., serving as a Pier, by a proper application of girders to their tops, affords ample space for the flow of the water between them, are susceptible of the most perfect system of diagonal bracing by the insertion of plates of metal between the blocks above the water line, or by stepping the Column at the proper points (Plate VIII); and as each rests upon the true foundation, and is in this respect entirely independent of all the others, the danger of failure from settling is reduced to a minimum.

For purposes of a draw, such Columns set in a circle with a central one for the pivot, offer the cheapest and most substantial provision; and present the least possible obstruction and consequent deflection to the current; a most important condition to the safe navigation of vessels through the narrow passages afforded by a draw.

For dry Bridges, and as a substitute for the mass of wooden trestle now used to carry the grade of railroads across ravines, marshes, swamps and shallow bays, they possess advantages of great value. The insecure character of such work, as now constructed, is apparent to the unprofessional as well as the professional mind.

Exposed to the ever present danger of fire, and the continual process of decay, it frequently happens that a fearful catastrophe is the first intimation of danger.

But perhaps no other specific case presents so strong an argument in behalf of their use, as the piling and trestle-work now depended on to carry the grades of railroads across the rivers and wide bayous of our Southern States.

Mr. G. W. R. Bayley, of New Orleans, the eminent civil engineer now in charge of the New Orleans, Mobile and Texas Railroad, in a most interesting and instructive paper upon the ravages of the ship worm (Teredo Navalis), read last summer before the Association already referred to, says:

"The long bridges across Bay St. Louis, 10,055 feet, and across Bay Biloxi, 6,136 feet, built on heavy yellow pine piles, from 15 to 20 inches and more in diameter, driven in 1869 and 1870, had to be reconstructed in the winter and spring of 1871, by driving an entire new set of piles in place of those destroyed by the Teredo."

It is not easy to overstate the peril to railroad travel resulting from an agency so hidden, and at the same time so rapid in its destruction as this. Working far below the surface of the water, entering the wood by an aperture so small as almost to defy detection, the worm operates unseen within the timber until it is utterly destroyed.

In vain may the superstructure be of the best quality, and be most vigilantly watched and guarded, if the supports upon which its stability must wholly depend are being eaten away by a silent enemy, against whose subtile industry no foresight or skill has yet been able to prevail.

Such Columns as we are describing, set in pairs at moderate distances, properly girded together at the tops, and diagonally braced, would afford a safe, cheap and easily constructed road bed across such places, capable of accommodating a double track when desirable, as well as in the approaches to, or passage through, large towns or cities, where street space cannot well be spared, or safely used; and be as durable as the granite of which they are built. Nor does a soft or muddy bottom preclude their use, for the "false work" of timber being cut off below that line, the stone is erected upon it and anchored to it, in the manner shown in Plate III., thus superseding the wood at the point where it is liable to attack.

Applied to retaining-walls, in the manner shown on Plate IX., they insure immobility of base by the anchorage to the foundation, and of the top by means of the "tie plates" and landward anchors, while the succession of horizontal arches between them afford far greater strength to resist the "thrust" of the filling with much less material, than is indispensable where gravity alone is depended upon.

Such a provision introduced into the sea-wall now being constructed around the water front of the City of New York, would obviously have prevented the "springing" of that ponderous and costly structure at the foot of Christopher Street, (which forms the subject of an explanatory article by the distinguished engineer, Gen'l Graham, published in the "*Times*" of the 15th instant,) by establishing a practical union between the wall and the false work upon which it rests, in addition to the very trifling one now maintained by the mere gravity of the structure, diminished as it is by immersion. The same thing is true in regard to "stone dams" (which are really retaining-walls for water instead of earth); and in both cases the work becomes a series of independent sections, any one of which may be built up or destroyed, without necessarily involving all the rest, as in the case of a continuous interlocked wall.

In the latter case, where the pressure is all on one side, the intermediate arches would of course be given a greater curvature, than where the wall is required to resist only the *difference* between the thrust of the filling on one side, and that of the water on the other.

Light Houses—Breakwaters—Beacons.

Although structures of this class are mainly undertaken only by the Government, they are nevertheless of such paramount importance to the commercial interests of the people, as well as so intimately associated with the material progress and just fame of the nation, that it is deemed proper to refer briefly to them here, as a matter of general public interest.

Certain it is, that no department of the public service involves greater responsibilities on the part of those who administer it To none are appropriations of the public money more generously or more cheerfully made—none has reflected more credit upon the nation during its comparatively brief existence, and none is capable of conferring upon it in the future, more of true and lasting renown, in the eyes of the civilized world, than that which has for its purpose and object the guarding and guiding of the mariner, as he traverses the great "Highway of Nations," or seeks the friendly shelter of the headlands and harbors of our own extensive coasts.

The history of Light Houses and Breakwaters, from the earliest periods of civilization to the present time, is the story of a continuous struggle between human ingenuity and perseverance on the one hand, and the destructive forces of nature on the other; in the course of which have been achieved some of the most notable triumphs of mechanical genius on record.

Conspicuous among the former stands the "Eddystone," in the English Channel. Commenced in 1696, finished in 1699, swept away in 1703, re-built in 1709, again destroyed in 1755, re-built by Smeaton in 1759; it stands to this day a grand monument to the genius of its constructor and the indomitable will of the British nation.

Hence it is, that any suggestion which promises to increase or assure the stability and durability upon which the value of such structures must very largely depend, or to make possible that which has hitherto been deemed to be impossible, is not only of interest to every intelligent citizen, but is sure to receive the most careful and deliberate consideration of those to whose supervision the erection of these structures has been delegated.

Along the seven thousand miles of sea coast belonging to the United States—to say nothing of three thousand miles of coast on the great lakes—there are numberless dangerous rocks (many of them bare at low tide,) of so small area at the surface of the water as to render it simply impossible to erect a permanent Light House foundation upon them in any sort of masonry hitherto used. The mariner must be warned of his danger in such cases, by a lightship depending solely upon moorings, maintained at great expense as near to the dangerous locality

as practicable, but always liable in exposed situations, to be displaced by ice or the force of great gales of wind.

Metal alone in such a situation is exposed to three distinct agencies of destruction: oxydation, vibration, (by which it is ultimately made to break where the lines of vibration meet,) and in the more northerly latitudes accumulations of ice upon the supporting shafts or piles to a dangerous and often fatal extent. The case of the iron Light House on Minot s Rock, off Boston Harbor, which was finished in 1849, and swept away in 1851, is an instance in illustration of the effect of one, if not of two, of these agencies.

Had the 10 inch Piles upon which that structure stood, been of rolled Bessemer Steel, and each been made the core of a hexagonal granite column similar to those shown in cluster on Plate X; and had each of such Columns been bound to a common centre by means of the "spider" imbedded between the courses, in the manner suggested, (Plate XI), it is quite safe to declare that they would not have been "twisted off near the point where they were held by the bed-rock."

All experience in relation to structures of ordinary masonry, either for Light House or Breakwater purposes, goes to show that the hydrostatic pressure of the water, which in proportion to its depth tends to raise the blocks of stone from their beds and the whole mass from the foundation, constitutes the most serious difficulty to be overcome.

This force being obviously at its greatest, just at the moment when the horizontal blow or "thrust" of the wave is exerted to produce a lateral movement, is now to be met and resisted, in the members and in the mass, only by the friction due to gravity, which is already diminished nearly forty per cent. by the displacement of water.

As stone, weighing out of the water, say 164 lbs. per cubic foot, weighs when submerged only 100 lbs., any additional stability, which is to be acquired by adding to the cubical contents of the structure, is to be obtained only at this disadvantage.

One of these disrupting forces being exerted vertically, and the other horizontally, both at the same instant, it is certain that the usual form of dovetailing the blocks together cannot resist *both;* but in the method of "bonding" now presented, each is specifically provided against, irrespective of the gravity, or the mortar, the former by the tensile strength of the vertical shafts, and the latter by the peculiar sectional shape of the Columns themselves.

This hexagonal shape may be used in any convenient size of blocks, without special regard to the sectional area to be produced; inasmuch as the figure may be protracted indefinitely around the same common centre, all the sides and angles remaining the same.

When a height sufficient to escape the most serious impact of the waves has been attained, the outer row of Columns may be discontinued and capped, producing an "offset" in

the structure at that point, and the remainder may continue to any desirable height, with or without further similar offsets.

The resistance offered by such a combination as this, in proportion to the area of surface exposed to the water, or in comparison with one of similar size built in the usual manner, and "bonded" only by its gravity, hardly needs to be demonstrated here.

Any interested person may soon make such a calculation for himself, the purpose of the present writing being mainly to bring to mind only such points as will be obvious, upon the most casual examination, rather than to tax the patience of the reader with figures, which in most instances he would prefer to make for himself.

The same remark may also be made as to details of cost of the Columns generally, which would of course vary widely in different localities, and therefore estimates would be practically useless, except when made for a specific case. As the materials required, however, are of a common and almost universal kind, and therefore readily quotable at any given point, (the metal in the form of steel rails,) little difficulty need be experienced in approximating very closely to the expense of a local structure of any given dimensions.

Any inquiries upon any of these points which may be addressed to this Company, will be most cheerfully answered, as well as in regard to the several uses of this Column for purposes, which for the sake of brevity, are not specifically designated here, as Monuments, out-of-door Chimneys, Church Spires, Buttresses to the walls of high buildings and the like.

CHARLES E. HILL, *President*,

American Pier and Column Co.

C. F. GREEN, *Secretary*.

NEW YORK, *Oct.* 29, 1874.

Plate II.

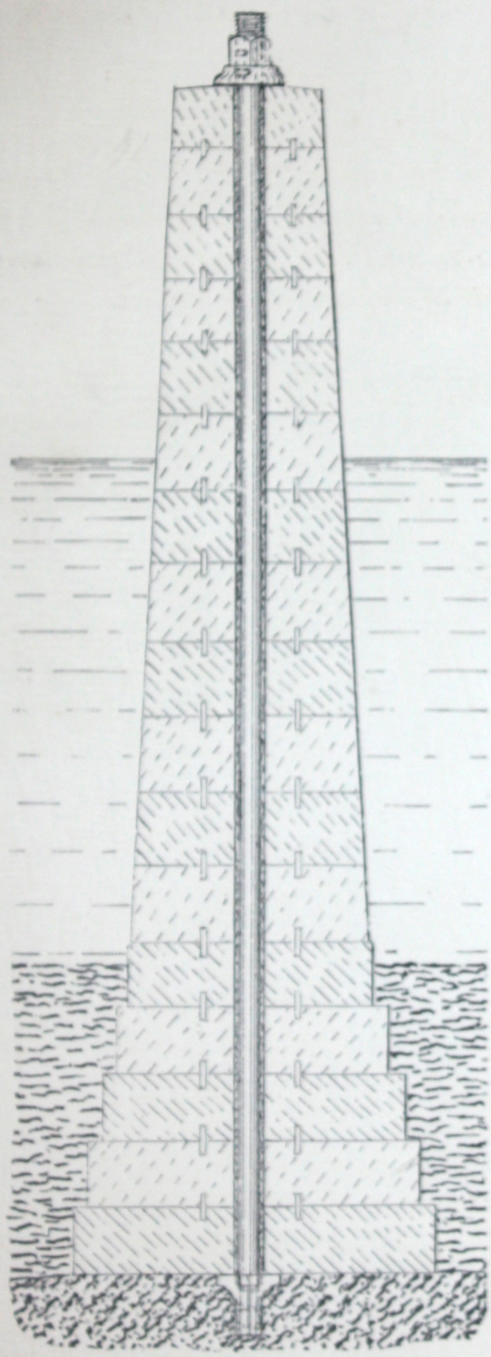
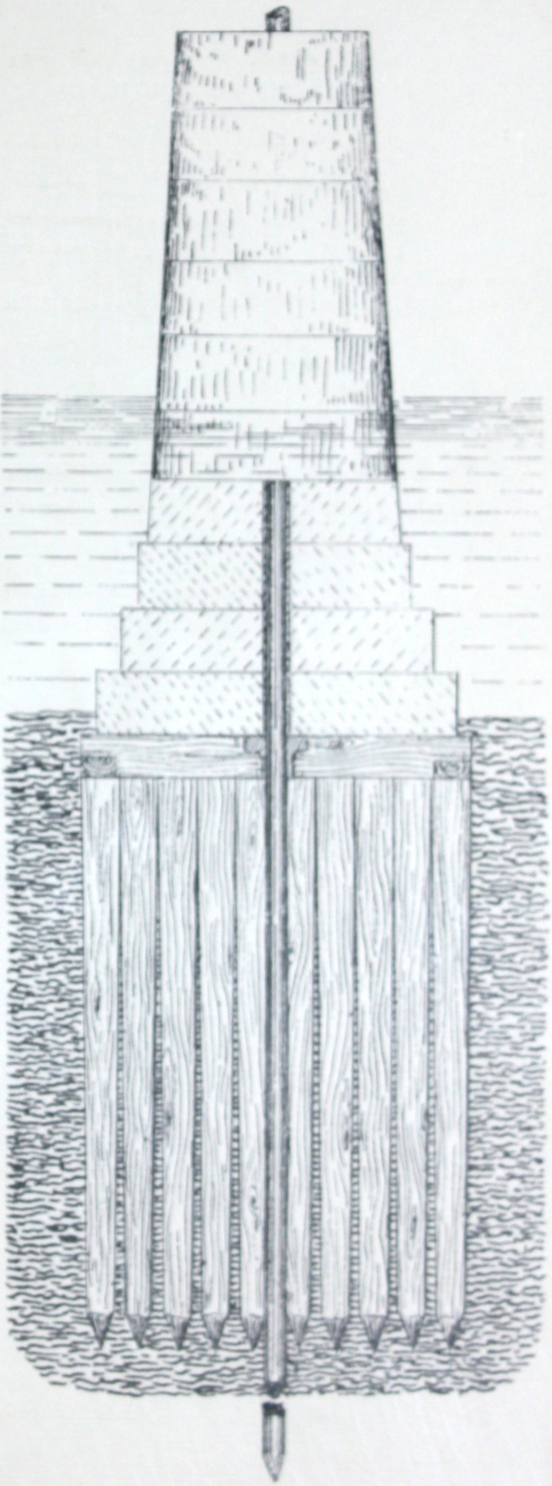
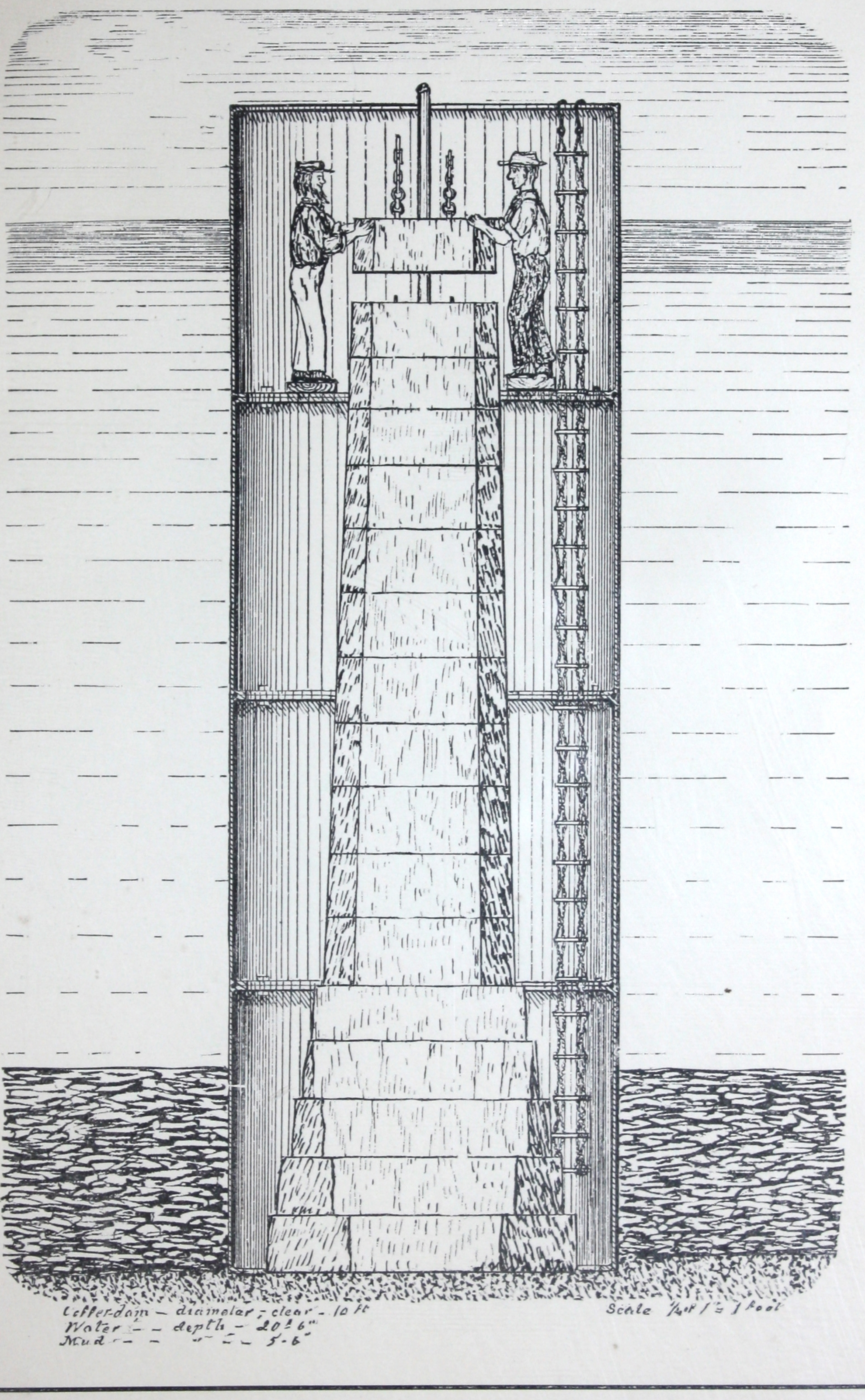
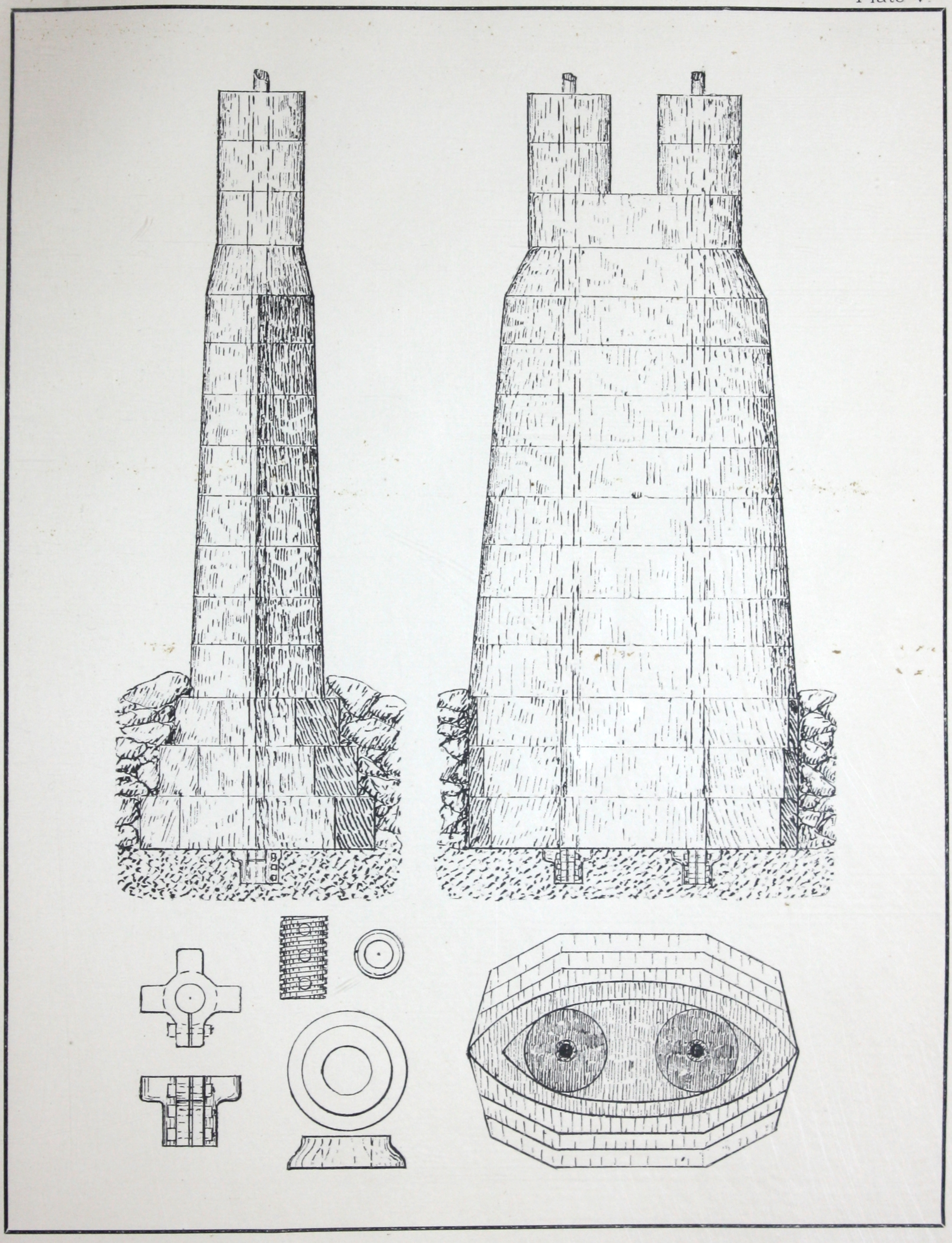
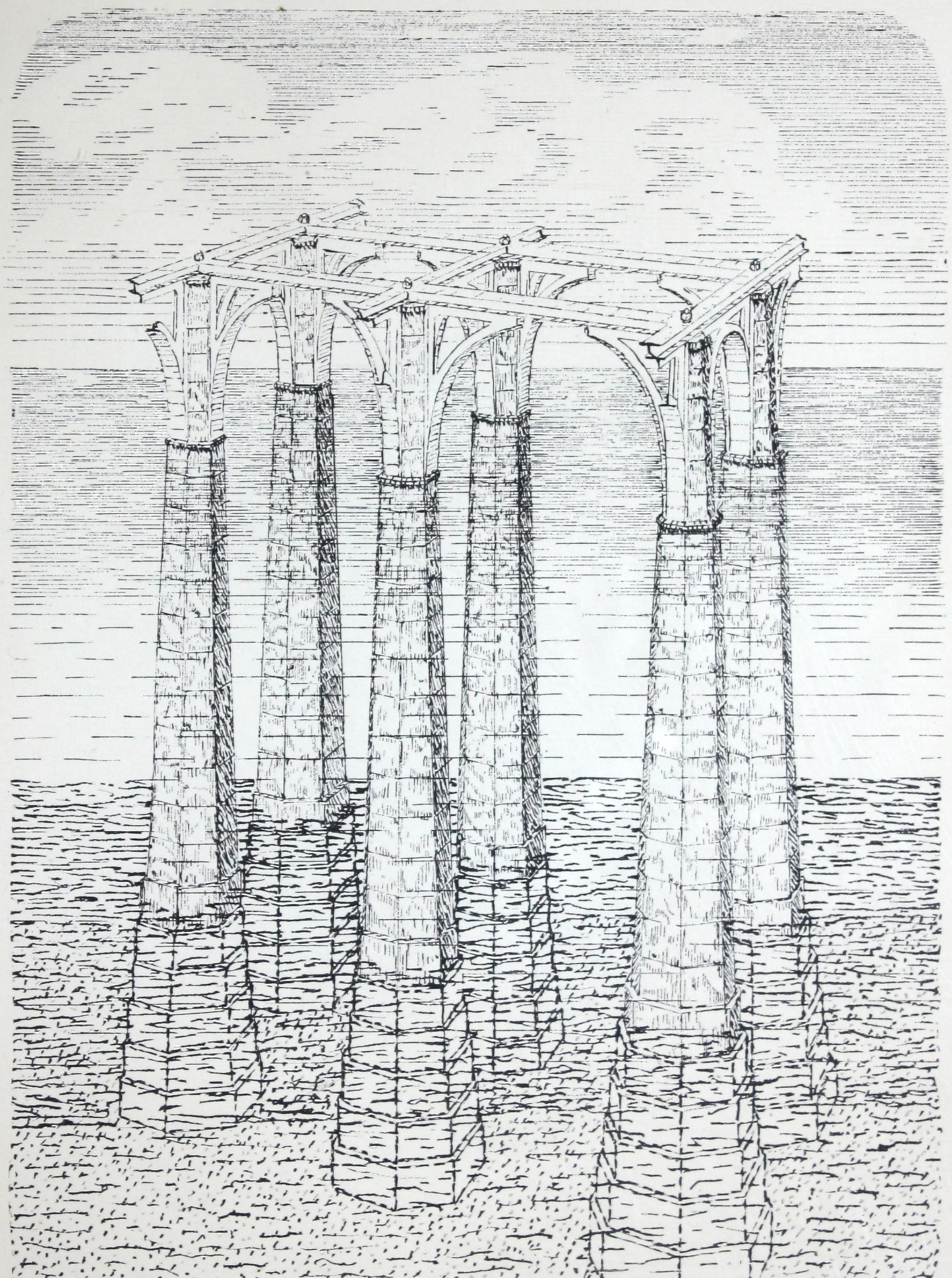


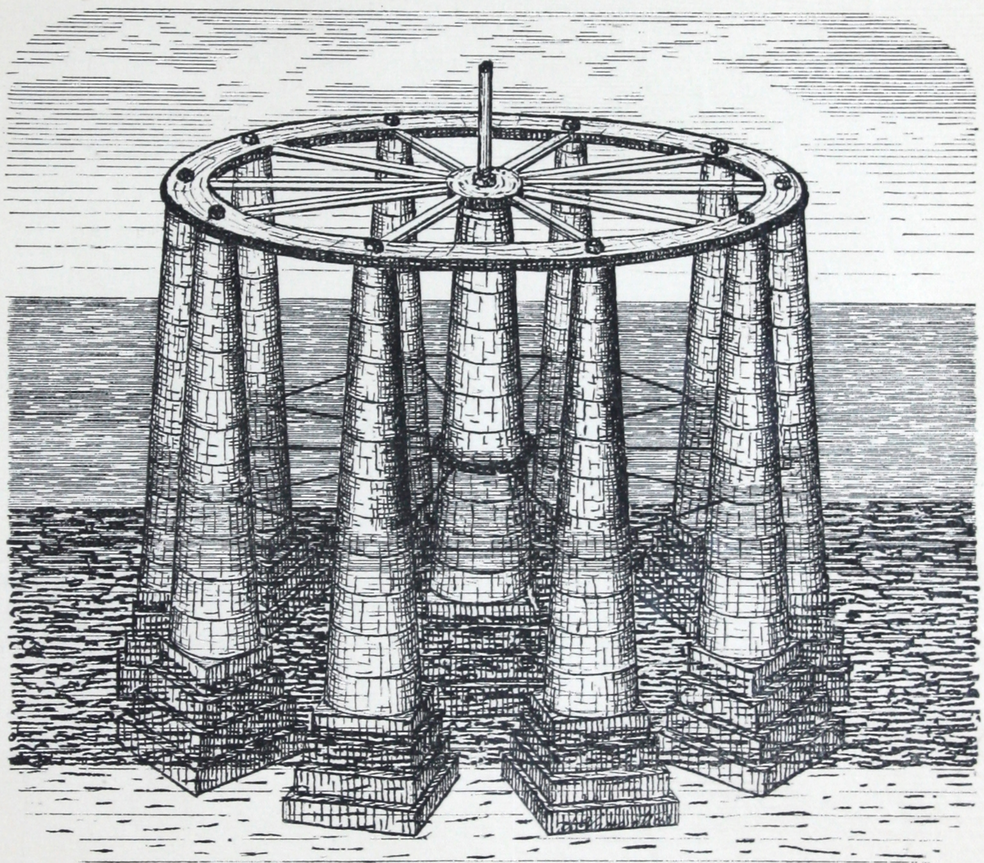
Plate III.




Coffer-dam – diameter – clear – 10 ft
Water – – depth – 20' 6"
Mud – – " – 5-6"
Scale 1/4" 1" = 1 foot







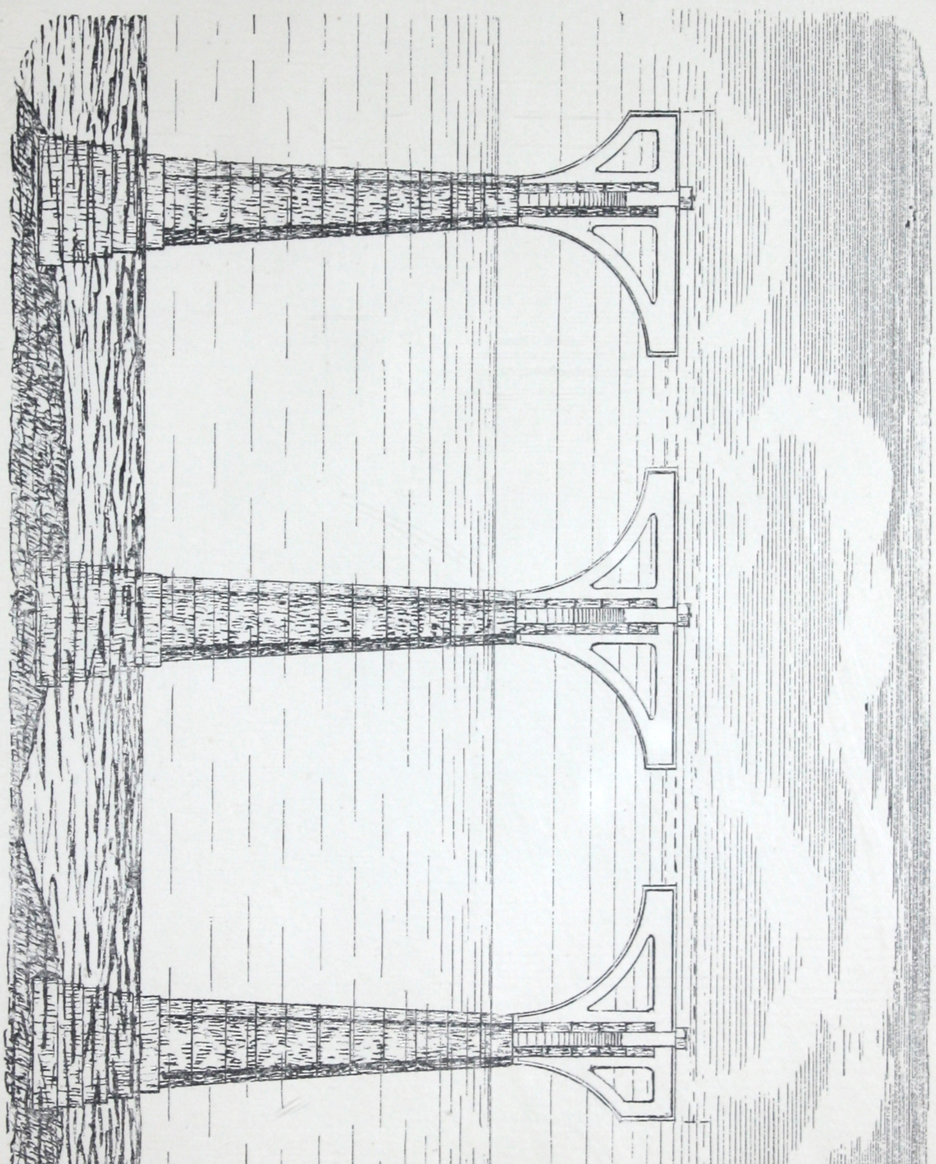


Plate IX.